

# GRAIN INSPECTION HANDBOOK

## BOOK II, CHAPTER 4

### CORN

CHAPTER 4

CORN

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#### **4.1 GENERAL INFORMATION**

- a. All quantities referenced in this chapter are approximate unless otherwise specified.
- b. Use an approved divider to obtain subportions of a sample for analysis unless otherwise specified.
- c. For specific Visual Reference Images, see Chapter 1, section 1.2, Visual Grading Aids.
- d. Official inspection personnel shall document inspection information during sampling and grading. See book IV, chapter 2.

The inspection process provides various factor information used to determine grade and to provide further information on the condition or quality of corn. Each section of this chapter provides details on recording factor information. If requested by the applicant for inspection, additional information may be provided (e.g., an exact count on stones in addition to the percentage by weight, a percentage for a specific type of damage, etc.).

#### **4.2 GRADES AND GRADE REQUIREMENTS**

Corn is divided into three classes based on color: Yellow corn, White corn, and Mixed corn. Each class is divided into five U.S. numerical grades and U.S. Sample Grade. Special grades are provided to emphasize special qualities or conditions affecting the value and are added to and made a part of the grade designation. They do not affect the numerical or sample grade designation.

**TABLE NO. 1 - GRADES AND GRADE REQUIREMENTS -  
CORN**

Grade	Minimum Limits of -	Maximum Limits of -		
	Test weight per bushel (pounds)	Heat-Damaged kernels (percent)	Damaged kernels total (percent)	Broken Corn and Foreign material (percent)
U.S. No. 1	56.0	0.1	3.0	2.0
U.S. No. 2	54.0	0.2	5.0	3.0
U.S. No. 3	52.0	0.5	7.0	4.0
U.S. No. 4	49.0	1.0	10.0	5.0
U.S. No. 5	46.0	3.0	15.0	7.0

U.S. Sample Grade:  
U.S. Sample Grade is corn that:

- (a) Does not meet the requirements for grades U.S. No.1, 2, 3, 4, or 5; or
- (b) Contains stones which have an aggregate weight in excess of 0.1 percent of the sample weight, 2 or more pieces of glass, 3 or more crotalaria seeds (Crotalaria spp.), 2 or more castor beans (Ricinus communis L.), 4 or more particles of an unknown foreign substance(s) or a commonly recognized harmful or toxic substance(s), 8 or more cockleburs (Xanthium spp.) or similar seeds singly or in combination, or animal filth in excess of 0.20 percent in 1,000 grams; or
- (c) Has a musty, sour, or commercially objectionable foreign odor; or
- (d) Is heating or otherwise of distinctly low quality.

### 4.3 GRADE DESIGNATIONS

After completing the analysis, compare the results with the limits for each grade factor specified in table 1. Use the following guidelines when assigning grades.

- a. The letters "U.S.",
- b. The abbreviation "No." and the number of the grade or the words "Sample Grade",
- c. The words "or better" when applicable,
- d. The name of the class and kind of grain,
- e. The special grade "Flint" when applicable,
- f. The special grade "Flint and Dent", (when applicable) along with the approximate percentage of flint corn,
- g. The special grade "Infested" when applicable, and

- h. The special grade "Waxy" (when applicable) shall be shown last in the grade designation.

When more than one special grade applies, list them in alphabetical order.

When certificating Mixed corn, record the percent of each corn in order of predominance in the "Remarks" section to the nearest tenth percent.

Examples: U.S. No. 2 White Corn, Infested  
U.S. Sample Grade Yellow Corn, Infested

#### 4.4 SPECIAL GRADES

Special grades identify unusual conditions in grain and are part of the grade designation. The corn standards include four special grades:

- a. Flint Corn. Corn that consists of 95 percent or more of flint corn.  
Example: U.S. No. 3 Yellow Corn, Flint
- b. Flint and Dent Corn. Corn that consists of a mixture of flint and dent corn containing more than 5.0 percent but less than 95 percent of flint corn.  
Example: U.S. No. 2 Yellow Corn, Flint and Dent, Flint Corn 35 percent
- c. Infested Corn. Corn that is infested with live weevils or other live insects injurious to stored grain.  
Example: U.S. No. 2 Yellow Corn, Infested
- d. Waxy Corn. Corn that consists of 95 percent or more waxy corn.  
Example: U.S. No. 1 White Corn, Waxy

## 4.5 OPTIONAL GRADE DESIGNATION

The Official U.S. Standards for Grain provide for an optional grade designation, commonly referred to as "or better." Upon the request of an applicant, corn may be certified as U.S. No. 2 or better, U.S. No. 3 or better, etc. An "or better" grade designation cannot be applied to a U.S. No. 1 grade designation.

Example: U.S. No. 3 or better Yellow Corn

## 4.6 BASIS OF DETERMINATION

*Distinctly Low Quality. The determination of distinctly low quality is made on the basis of the lot as a whole at the time of sampling when a condition exists that may or may not appear in the representative sample and/or the sample as a whole.*

*Certain Quality Determinations. Each determination of rodent pellets, bird droppings, other animal filth, broken glass, castor beans, cockleburrs, crotalaria seeds, dockage, garlic, live insect infestation, large stones, moisture, temperature, and unknown foreign substance(s), and a commonly recognized harmful or toxic substance(s) is made on the basis of the sample as a whole. When a condition exists that may not appear in the representative sample, the determination may be made on the basis of the lot as a whole at the time of sampling according to procedures prescribed in FGIS instructions.*

*All Other Determinations. Each determination of class, damaged kernels, heat-damaged kernels, waxy corn, flint corn, and flint and dent corn is made on the basis of the grain after the removal of the broken corn and foreign material. Other determinations not specifically provided for under the General Provisions are made on the basis of the grain as a whole, except the determination of odor is made on either the basis of the grain as a whole or the grain when free from broken corn and foreign material.*



TABLE NO. 2

BASIS OF DETERMINATION		
Lot as a Whole	Factors Determined Before the Removal of Broken Corn and Foreign Material	Factors Determined After the Removal of Broken Corn and Foreign Material
Distinctly low quality Heating Infested Odor	Distinctly low quality Heating Infested Kind of Grain Moisture Odor Stones Test Weight U.S. Sample Grade factors	Class Damaged kernels Flint corn Flint and dent corn Heat-damaged kernels Odor Waxy

The following sections of this chapter are arranged in a sequence typically followed in the inspection and grading of corn.

#### 4.7 DEFINITION OF CORN

Corn is defined as:

*Grain that consists of 50 percent or more of whole kernels of shelled dent corn and/or shelled flint corn (Zea mays L.) and may contain not more than 10.0 percent of other grains for which standards have been established under the United States Grain Standards Act.*

Whole kernels are kernels with three-fourths or more of the kernel present. Other grains for which standards have been established are barley, canola, flaxseed, oats, rye, sorghum, soybeans, sunflower seed, triticale, and wheat.

**Basis of Determination.** Normally, a visual appraisal of the sample is sufficient to determine if it meets the definition of corn. However, if an analysis is necessary, make the determination before the removal of broken corn and foreign material on a portion of 250 grams.

If the sample does not meet the definition of corn, examine it further to determine if it is:

- a. Another grain for which standards have been established or
- b. Not standardized grain. No further analysis is necessary on a sample designated as not standardized grain unless a specific factor test is requested.

#### 4.8 HEATING

Corn developing a high temperature from excessive respiration is considered heating. Heating corn, in its final stages, will usually have a sour or musty odor. Care should be taken not to confuse corn that is heating with corn that is warm and moist because of storage in bins, railcars, or other containers during hot weather.

**Basis of Determination.** Determine heating on evidence obtained at the time of sampling or on the basis of the sample as a whole.

**Certification.** Grade heating corn as U.S. Sample Grade and record the word "Heating" in the "Remarks" section of the certificate.

#### 4.9 ODOR

**Basis of Determination.** Determine odor on evidence obtained at the time of sampling or on the sample either before or after the removal of broken corn and foreign material.

**TABLE NO. 3**

ODOR CLASSIFICATION EXAMPLES		
Sour	Musty	Commercially Objectionable Foreign Odors
Boot Fermenting Insect (acid) Pigpen	Ground Insect Moldy	Animal hides Decaying animal and vegetable matter Fertilizer Fumigant Insecticide Oil products Skunk Smoke Strong weed

**Commercially Objectionable Foreign Odors.** Commercially objectionable foreign odors are odors foreign to grain that render it unfit for normal commercial usage.

Fumigant or insecticide odors are considered commercially objectionable foreign odors if they linger and do not dissipate. When a sample of corn contains a fumigant or insecticide odor that prevents a determination as to whether any other odor(s) exists, apply the following guidelines:

- a. Original Inspections. Allow the work portion to aerate in an open container for 4 hours, or less, if the odor dissipates in less time.
- b. Reinspections, Appeal, and Board Appeal Inspections. Allow unworked file samples and new samples to aerate in an open container for 4 hours, or less, if the odor dissipates in less time. The 4-hour aeration requirement does not apply when the original work portion was aerated and retained as the final file.

Consider the sample as having a commercially objectionable foreign odor if the fumigant or insecticide odor persists based on the above criteria.

**Final Determination.** The inspector(s) is responsible for making the final determination for all odors. A consensus of experienced inspectors is used, whenever possible, on samples containing marginal odors. The consensus approach is not required if no odor or a distinct odor is detected.

**Certification.** Grade corn containing a "distinct" musty, sour, or commercially objectionable foreign odor as U.S. Sample Grade. Record the words "Musty," "Sour," or "Commercially Objectionable Foreign Odor" in the "Remarks" section of the certificate.

#### 4.10 MOISTURE

*Water content in grain as determined by an approved device according to procedures prescribed in FGIS instructions.*

**Basis of Determination.** Determine moisture before the removal of broken corn and foreign material on a portion of approximately 650 grams.

The procedures for performing a moisture determination using the GAC2500-UGMA and Perten AM 5200-A moisture meters are described in Moisture Handbook.

**Certification.** Record the percent of moisture on the certificate to the nearest tenth percent.

#### 4.11 TEST WEIGHT

*The weight per Winchester bushel (2,150.42 cubic inches) as determined using an approved device according to procedures prescribed in FGIS instructions.*

**Basis of Determination.** Determine test weight before the removal of broken corn and foreign material on a portion of sufficient quantity to overflow the kettle.

The procedures for performing the test weight determination and available services are described in book II, chapter 1, section 1.11.

**Certification.** Record test weight results on the work record as displayed on the electronic scale or in whole and tenth pounds to the nearest tenth pound. Record the test weight on the certificate in whole and tenth pounds to the nearest tenth pound. If requested, convert the pounds per bushel (lb/bu) result to kilograms per hectoliter (kg/hl) using the following formula:  $\text{lb/bu} \times 1.287 = \text{kg/hl}$  and record in the “Remarks” section in whole and tenths.

#### 4.12 INFESTED CORN

Infested corn is corn that is infested with live weevils or other live insects injurious to stored grain.

The presence of any live weevil or other live insects injurious to stored grain found in the work sample indicates the probability of infestation and warns that the corn must be carefully examined to determine if it is infested. In such cases, examine the work sample and the file sample before reaching a conclusion as to whether or not the corn is infested. Do not examine the file sample if the work sample is insect free.

Live weevils include rice weevils, granary weevils, maize weevils, cowpea weevils, and lesser grain borers. Other live insects injurious to stored grain shall include grain beetles, grain moths, and larvae. (See Chapter 1, Section 1.2, Visual Grading Aids.)

**Basis of Determination.** Determine infestation on the lot as a whole or the sample as a whole. For insect tolerances, see table No. 4.

**TABLE NO. 4**

<b>INSECT INFESTATION</b>		
<i>Samples meeting or exceeding any one of these tolerances are infested:</i> <b>2 lw, or 1 lw + 5 oli, or 10 oli</b>		
1,000-gram representative sample <u>1/</u> (+ file sample if needed)	Lot as a Whole (Stationary)	Online Sample (In-Motion) <u>2/</u>
Submitted samples Probed lots D/T sampled land carriers	Probed lots (at time of sampling)	Railcars under the Cu-sum Subsamples for Sacked Grain lots Components for Bargelots <u>3/</u> Components for Shiplots <u>3/</u>
<u>1/</u> Examine work portion and file sample if necessary. Do not examine file sample if work portion is insect free. <u>2/</u> Minimum sampling rate is 500 grams per 2,000 bushels. <u>3/</u> Minimum component size is 10,000 bushels. <u>Key:</u> lw = live weevil, oli = other live insects injurious to stored grain		

**Certification.** When applicable, record the word "Infested" on the certificate in accordance with Section 4.4, Special Grades.

#### **4.13 DISTINCTLY LOW QUALITY**

Consider corn distinctly low quality when it is obviously of inferior quality and the existing grade factors or guidelines do not accurately reflect the inferior condition.

**Basis of Determination.** Use all available information to determine whether the corn is of distinctly low quality. This includes a general examination of the corn during sampling and an analysis of the obtained sample(s).

Large Debris. Corn containing two or more stones, pieces of glass, pieces of concrete, or other pieces of wreckage or debris which are visible to the sampler but are too large to enter the sampling device is considered distinctly low quality.

Other Unusual Conditions. Corn that is obviously affected by other unusual conditions which adversely affect the quality of the corn and cannot be properly graded by use of the grading factors specified or defined in the standards is considered distinctly low quality.

Corn suspected of containing diatomaceous earth is considered distinctly low quality unless the applicant specifically requests an examination to verify the presence of diatomaceous earth. If the laboratory examination verifies that the corn contains diatomaceous earth, then the corn is not considered distinctly low quality due to diatomaceous earth. Refer to Program Directive 9180.49, Grading and Certification of Grain Containing Diatomaceous Earth and Silica Gel, for additional information regarding the testing of corn for diatomaceous earth.

**Certification.** Grade distinctly low quality corn as U.S. Sample Grade. Record the words "Distinctly Low Quality" and the reason(s) why in the "Remarks" section of the certificate.

#### **4.14 U.S. SAMPLE GRADE CRITERIA**

**Basis of Determination.** Determine U.S. Sample Grade criteria before the removal of broken corn and foreign material based on a work portion of 1,000 to 1,050 grams. Table No. 5 shows the criteria and corresponding Visual Reference Images, tolerance limits, and the appropriate basis of determination. Consider identifiable pieces of grain, processed grain products (e.g., soybean meal, sorghum grits, corn meal, bulgur, etc.), or feed pellets in grain as foreign material. Unidentifiable materials or material unrelated to grain shall function as "unknown foreign substance."

TABLE NO. 5

U.S. SAMPLE GRADE CRITERIA			
Criteria	Visual Reference Image	Number/Weight <u>1/</u>	
		Sample Basis	Lot Basis <u>2/</u>
Any numerical grading factor		Excess of limit for U.S. No. 5	N/A
Animal filth	<a href="#">OF-Animal Filth</a>	Excess of 0.20%	N/A
Castor Beans	<a href="#">OF-Castor-Bean</a>	2 or more	N/A
Cockleburs	<a href="#">OF-Cockle Burs.</a>	8 or more	N/A
Crotalaria seeds	<a href="#">OF-Crotalaria</a>	3 or more	N/A
Glass		2 or more	N/A
Odor		Presence	N/A
Stones		excess of 0.1% by weight	N/A
Unknown foreign substances <u>3/</u>	<a href="#">OF-Fertilizer</a>	4 or more	N/A
Heating		Presence	Presence
Large Debris *		N/A	2 or more
Other unusual conditions *		Presence	Presence
<u>1/</u> Record count factors to the nearest whole number.			
<u>2/</u> The entire sample of a submitted sample is considered as the lot.			
<u>3/</u> Consider feed pellets and processed grain products as foreign material, not unknown foreign substance.			
* For Distinctly Low Quality, see section 4.13			

**Certification.** Grade corn U.S. Sample Grade when one or more of the limits in table 5 are exceeded. Record the reason(s) why in the "Remarks" section of the certificate. Record count factors to the nearest whole number.

#### 4.15 BROKEN CORN AND FOREIGN MATERIAL

*Broken Corn.* All matter that passes readily through a 12/64 round-hole sieve and over a 6/64 round-hole sieve according to procedures prescribed in FGIS instructions.

*Foreign Material.* All matter that passes readily through a 6/64 round-hole sieve and all matter other than corn that remains on top of the 12/64 round-hole sieve after sieving according to procedures prescribed in FGIS instructions.

*Broken Corn and Foreign Material.* All matter that passes readily through a 12/64 round-hole sieve and all matter other than corn that remains in the sieved sample after sieving according to procedures prescribed in FGIS instructions.

**Basis of Determination.** Determine the factor broken corn and foreign material (BCFM) on a portion of 1,000 to 1,050 grams.

**Procedure.** The approved methods for determining the factor BCFM are the methods described in this section. .

The procedure is performed in two steps: A mechanical separation of BCFM is made using a Carter Dockage Tester to remove the larger and finer particulate matter from the sample. The mechanically cleaned sample is then handpicked to remove any remaining similarly sized foreign material from the sample. To avoid repeating operations, check the material found in the BCFM sieve catch pans for live weevils and other live insects injurious to stored grain, stones, distinctly low quality, and other sample grade factors. Live weevils, other live insects injurious to stored grain, and sample grade factors are considered FM but, when present in sufficient quantities, are considered in the determination of U.S. Sample Grade and/or the special grade "Infested."



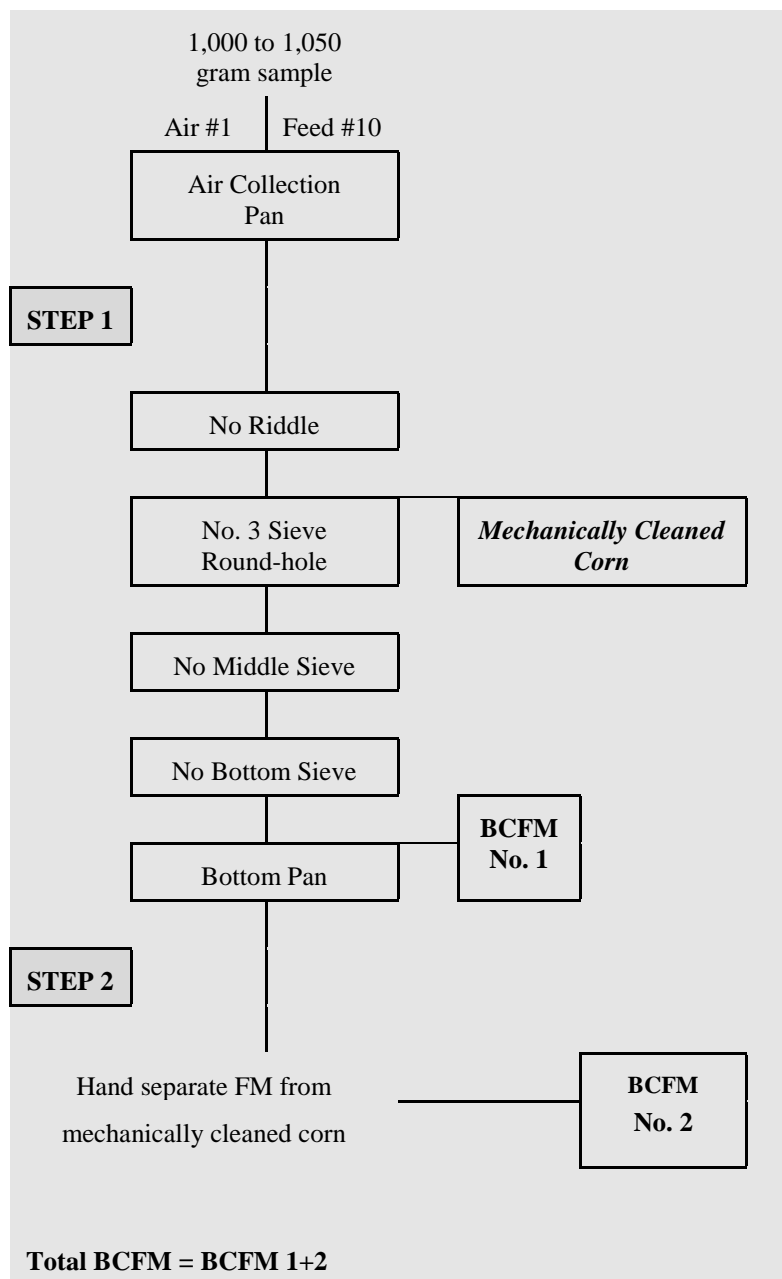
**CHART 1 - PROCEDURE FOR DETERMINING BCFM**

**STEP 1. Carter Dockage Tester.**

- a. Set the air control to 1 and the feed control to 10.
- b. Insert the No. 3 sieve in the top sieve carriage
- c. Run 1,000 – 1,050 grams through the dockage tester.

**STEP 2. Handpick (foreign material)**

- a. Remove all matter other than corn, including sweet corn, blue corn, and popcorn. (Reference: Visual Reference Image No. OF-7.4), from the mechanically cleaned portion.
- b. Combine the mechanically separated and handpicked BCFM.



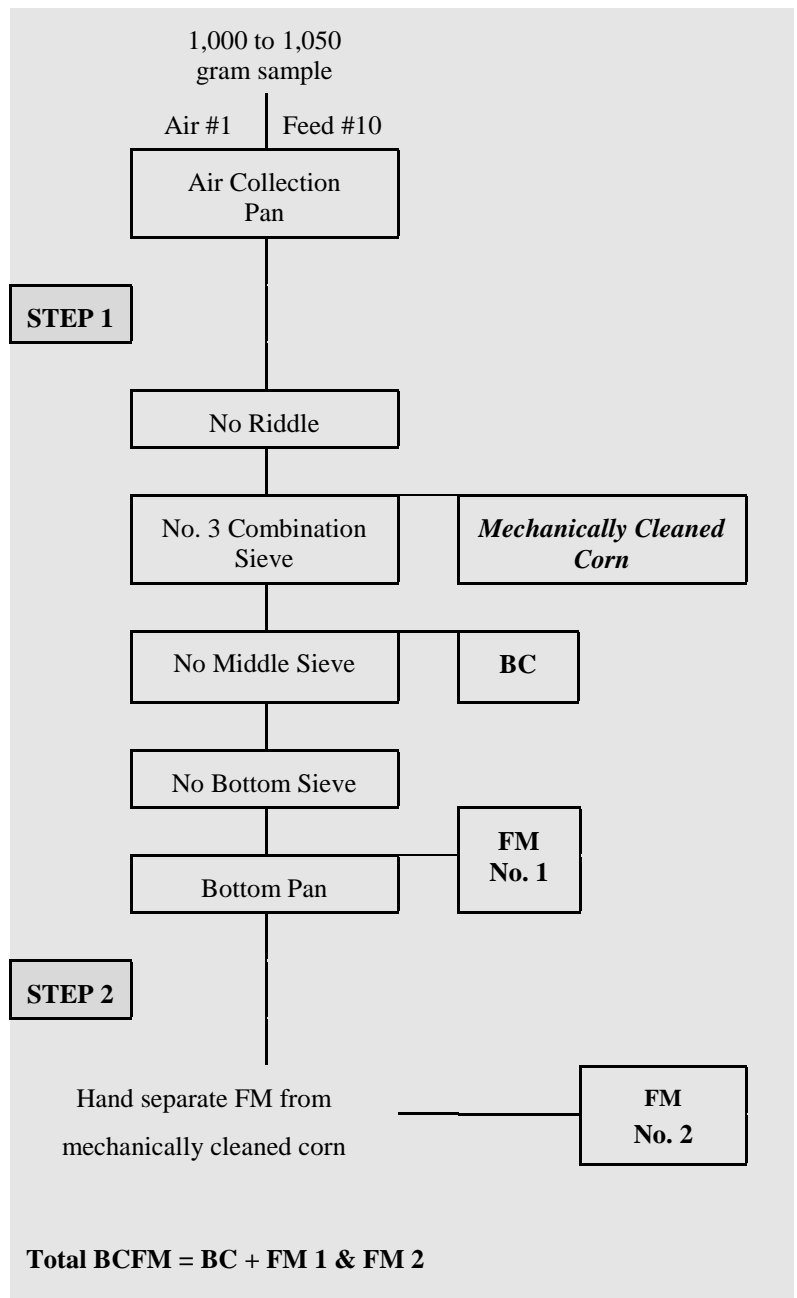
**Certification.** Record the percentage of BCFM on the certificate to the nearest tenth percent. Upon request, use the following alternate procedure which allows for the separation of BC and FM.

## CHART 2 – ALTERNATE PROCEDURE FOR DETERMINING BC AND FM

- STEP 1. Carter Dockage Tester.**
- Set the air control to 1 and the feed control to 10.
  - Insert the combination 12/64 inch and 6/64 inch No. 3 sieve in the top sieve carriage
  - Run 1,000 – 1,050 grams through the dockage tester.
  - BC consists of all material passing through the 12/64 inch sieve and over the 6/64 inch sieve (collected in the middle sieve collection pan)
  - FM consists of all material passing through the 6/64 inch sieve (collected in the bottom collection pan).

**STEP 2. Handpick (foreign material)**

- Remove all matter other than corn, including sweet corn, blue corn, and popcorn. (Reference: Visual Reference Image No. OF-7.4), from the mechanically cleaned portion.
- Combine the mechanically separated and handpicked FM.



**Alternate Procedure for Determining BCFM (Hand Sieve Method).** Official personnel have the option of manually hand-sieving or mechanically sieving (using a sizer shaker) the BCFM portion.

Follow the procedures listed below to separate the components BC and FM from machine (Carter Dockage Tester) separated BCFM.

a. Mechanically Sieving Method.

1. Mount a 6/64 round-hole hand sieve and a bottom collection pan on a mechanical sieve shaker.
2. Set the stroke counter to 5.
3. Remove the BCFM collection pan from the Carter Dockage Tester and pour the contents into the center of the 6/64 round-hole sieve.
4. Turn the sieve shaker on.
5. After the sieve shaker has stopped carefully remove the sieve and bottom collection pan.
6. Combine the material that lodged in the perforations with the material that remained on top of the sieve. Consider this material as broken corn.
7. Consider the material in the bottom collection pan as foreign material.
8. Remove all matter other than corn, including sweet corn, blue corn, and popcorn from the mechanically (Carter Dockage Tester) cleaned portion and combine with the foreign material in step 7 above. This combination of mechanically separated FM and hand-picked FM functions as foreign material.
9. Calculate the percentages of BC and FM separately.

b. Hand Sieving Method.

1. Mount a 6/64 round-hole hand sieve to a bottom collection pan.
2. Remove the BCFM collection pan from the Carter Dockage Tester and pour the contents into the center of the 6/64 round-hole sieve.
3. Hold the sieve level in both hands with elbows close to the body.

4. In a steady motion, move the sieve from left to right approximately 10 inches and then return from right to left.
5. Repeat this operation 5 times.
6. Combine the material that lodged in the perforations with the material that remained on top of the sieve. Consider this material as broken corn.
7. Consider the material in the bottom collection pan as foreign material.
8. Remove all matter other than corn, including sweet corn, blue corn, and popcorn from the mechanically (Carter Dockage Tester) cleaned portion and combine with the foreign material in step 7 above. This combination of mechanically separated fm and hand-picked FM functions as foreign material.
9. Calculate the percentages of BC and FM separately.

**Adjustment of Factors.** In certain instances, when using the alternate procedure, the sum of BC and FM in corn, due to rounding, will not equal the percentage of BCFM recorded on the certificate. When this occurs, it is necessary to adjust the component nearest a midpoint (e.g.; .05, .15, .25, .35, etc.) by adding or subtracting 0.1.

#### Example

Original sample weight	1,012 grams
Weight of BC	38.34 grams
Weight of FM	2.64 grams
Weight of BCFM	40.98 grams

**STEP 1**  $(38.34 \div 1,012) \times 100 = 3.78\%$  BC (rounded 3.8%).

**STEP 2**  $(2.64 \div 1,012) \times 100 = 0.26\%$  FM (rounded 0.3%).

**STEP 3**  $(40.98 \div 1,012) = 4.04\%$  BCFM (rounded 4.0%).

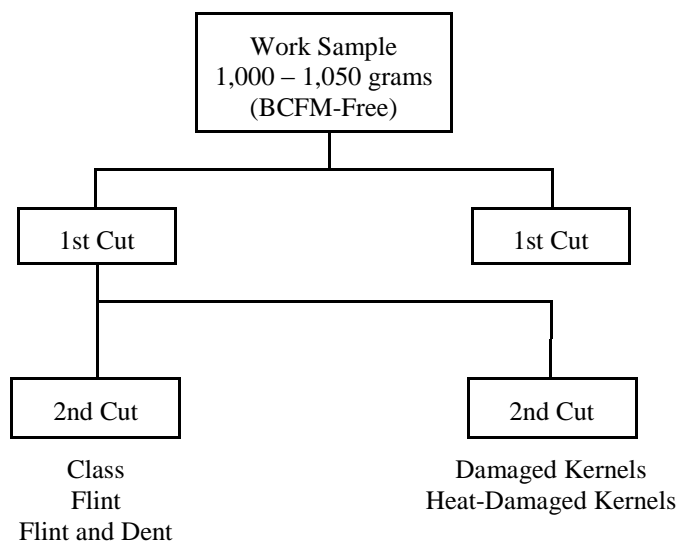
Since the sum of the rounded BC and FM results (3.8% BC + 0.3% FM = 4.1%) does not equal the rounded BCFM results (4.0% BCFM), an adjustment of -0.1 is needed. In this instance, the rounded result for FM (0.3%) is adjusted downward to 0.2% because the unrounded result (0.26%) is nearer to a midpoint (0.25) than the unrounded result for BC.

**Certification.** Record the percentage of BC and the percentage of FM separately to the nearest tenth in the "Remarks" section of the certificate for nonexport shipments and on the loading log or similar work record for export shipments. In the "Factor" block of the certificate, record the total percentage of BCFM to the nearest tenth percent.

#### 4.16 PROCESSING THE WORK SAMPLE

After determinations have been made for odor, test weight, moisture, BCFM, infestation, and sample grade factors, divide the work sample into portions as shown in table 6.

**CHART 3 - DIVIDING THE WORK SAMPLE**



**TABLE NO. 6**

APPROXIMATE ANALYTICAL PORTION SIZES	
<i>Factors</i>	<i>Grams</i>
Class	250
Damaged kernels	250
Flint corn	250
Flint and dent corn	250
Heat-damaged kernels	250

#### 4.17 CLASS

Corn is divided into the following three classes:

- a. *Yellow Corn.* *Corn that is yellow-kerneled and contains not more than 5.0 percent of corn of other colors. Yellow kernels of corn with a slight tinge of red are considered Yellow corn.*

The term "yellow kernels of corn with a slight tinge of red" includes kernels which are yellow and/or light red in color and kernels which are yellow and dark red in color provided the dark red color covers less than 50 percent of the kernel. Yellow and red kernels in which the dark red color covers 50 percent or more of the kernel are considered "Corn of Other Colors." (Reference: Visual Reference Image No. [\(C\) O.F.-7.5 Corn of Other Colors](#))

- b. *White Corn.* *Corn that is white-kerneled and contains not more than 2.0 percent of corn of other colors. White kernels of corn with a slight tinge of light straw or pink color are considered White corn.*

White corn with a slight tinge of light straw applies to all White corn, except corn found to be waxy. For the specification pertinent to waxy corn, see section 4.21.

The term "white kernels of corn with a slight tinge of light straw or pink color" includes kernels which are white and/or light straw or light pink in color and kernels which are white and pink in color provided the pink color covers less than 50 percent of the kernel. White and pink kernels in which the pink color covers 50 percent or more of the kernel are considered "Corn of Other Colors." (Reference: Visual Reference Image Nos. [\(C\) O.F.-7.1 Mixed Corn \(Slight-Tinge-Straw\)](#) and [\(C\) O.F.-7.71 Mixed Corn \(Slight-Tinge Pink\)](#))

- c. *Mixed Corn.* *Corn that does not meet the color requirements for either of the classes Yellow corn or White corn and includes white-capped Yellow corn.* (Reference: Visual Reference Image No. [\(C\) O.F.-7.2 Mixed Corn \(White-Capped Yellow\)](#))

**NOTE: When determining the class of corn, consider "Indian Corn" as "Corn of Other Colors."**

**Basis of Determination.** Determine the class of corn by the color characteristics of the kernels. When an analysis for class is necessary, use a 250-gram portion of BCFM-free corn.

**Certification.** Record the percentage of corn of other colors on the certificate to the nearest tenth percent. When certifying Mixed corn, record the percentage of the mixture, in the order of predominance, in the "Remarks" section to the nearest tenth percent.

#### 4.18 DAMAGED KERNELS

*Kernels and pieces of corn kernels that are badly ground-damaged, badly weather-damaged, diseased, frost-damaged, germ-damaged, heat-damaged, insect-bored, mold-damaged, sprout-damaged, or otherwise materially damaged.*

**Basis of Determination.** Determine the amount of damaged kernels on a 250-gram portion of BCFM-free corn.

##### TYPES OF CORN DAMAGE.

A kernel of corn is considered damaged for inspection and grading purposes when the damage is distinctly apparent and of such character as to be recognized as damaged for commercial purposes.

Blue-eye Mold. A germ infected with blue-eye mold, regardless of amount. If the mold is distinct, it is not necessary to open or scrape the kernel. Otherwise, lift the germ cover carefully to avoid destroying the evidence of mold. (Reference: Visual Reference Image No. [Corn-1.0 Blue-Eye Mold Damage](#))

Do not confuse purple plumule with blue-eye mold. Purple plumule is not damage but is a genetic or varietal characteristic. (Reference: Visual Reference Image No. [C-1.1 Purple Plumule \(Not Damage\)](#))

Cob Rot. Cob rot is caused by a fungus that attacks weakened plants. It is detected by the presence of a distinct discoloration or rotting. Opening the kernel is not required to detect cob rot but may be necessary to determine the extent of other types of damage. (Reference: Visual Reference Image No. [C-2.0 Cob Rot Damage](#))

Drier-Damaged Kernels. Kernels and pieces of kernels which have a discolored, wrinkled, and blistered appearance; or which are puffed or swollen and slightly discolored and which often have damaged germs; or whose seed coats are peeling off or have already peeled off; or which have a fractured or checked appearance resulting from external heat caused by artificial drying methods. Do not confuse drier damage with heat damage (drier). (Reference: Visual Reference Image No. [C-3.0 Drier Damage](#))

Germ-Damaged Kernels (slight discoloration by respiration). Kernels and pieces of kernels damaged by respiration or heat but not materially discolored. (Reference: Visual Reference Image No. [C-4.0 Germ Damage](#)) In most cases, the germ covering will have to be removed, exposing the area around the plumule. The discoloration must extend into the meat of the germ to be considered damaged.

Heat-Damaged Kernels. Kernels and pieces of kernels which are materially discolored by excessive respiration, with the dark discoloration extending out of the germ through the sides and into the back of the kernel. (Reference: Visual Reference Image No. [C-5.1 Heat Damage \(White\)](#) for Heat-damaged White corn and No. [C-5.2 Heat Damage \(Yellow\)](#) for Heat-damaged Yellow corn.)

Heat-Damaged Kernels (drier). Kernels and pieces of kernels which are puffed or swollen and materially discolored by external heat caused by artificial drying methods. (Reference: Visual Reference Image No. [C-5.0 Heat Damage \(Drier\)](#))

Insect-Bored Kernels. Kernels and pieces of kernels with obvious insect-bored holes or which have tunneling, insect webbing, or insect refuse. Do not consider kernels partially eaten but entirely free from refuse, webbing, insects, or other forms of damage as damaged. (Reference: Visual Reference Image No. [C-6.0 Insect Damage](#)) Do not cut open the kernel when making this determination. If the determination for insect-bored damage cannot be made without cutting the kernel, the kernel is considered damaged.

Mold-Damaged Kernels. Kernels and pieces of kernels infected with mold on exposed endosperm. When a kernel of corn has been broken exposing the starch, it becomes susceptible to mold. Check broken pieces carefully for mold. (Reference: Visual Reference Image No. [C-7.0 Mold Damage](#)) Do not confuse kernels that have dirt on them with kernels containing mold. Mold is usually blue or green in color. (Reference: Visual Reference Image No. [C-7.1 Not Damage \(Dirt\)](#))

Mold-like Substance. Whole kernels of corn which are 50 percent or more covered and pieces of kernels which are discolored and covered with a mold-like substance.

Silk-Cut Kernels. Kernels and pieces of kernels with mold in silk cuts. Kernels with clean silk cuts and are otherwise sound are not considered as being damaged. (Reference: Visual Reference Image No. [C-8.0 Silk Cut](#))

Surface Mold (blight). Kernels and pieces of kernels which have mold caused by corn leaf blight on them which appears to be only on the surface but actually penetrates the seed coats. (Reference: Visual Reference Image No. [C-10.0 Blight](#))

Surface Mold. Kernels and pieces of kernels which contain surface mold in any area or combination of areas equal to or greater than shown on the Visual Reference Image. (Reference: Visual Reference Image No. [C-11.0 Surface Mold](#))

Mold (pink Epicoccum). Kernels and pieces of kernels with germs infected with mold. (Reference: Visual Reference Image No. [C-7.2 Mold \(Pink Epicoccum\)](#))

Sprout-Damaged Kernels. Sprouted kernels or those showing evidence of a sprout. (Reference: Visual Reference Image No. [C-9.0 Sprout Damage](#))



**Certification.** Record the percent of damaged kernels on the certificate to the nearest tenth percent.

#### 4.19 HEAT-DAMAGED KERNELS

*Kernels and pieces of corn kernels that are materially discolored and damaged by heat.*

**Basis of Determination.** Determine heat-damaged kernels on a portion of 250 grams of BCFM-free corn. (Reference: Visual Reference Image Nos. [C-5.0 Heat Damage \(Drier\)](#), [C-5.1 Heat Damage \(White\)](#), and [C-5.2 Heat Damage \(Yellow\)](#))

**Certification.** Record the percent of heat-damaged kernels on the certificate to the nearest tenth percent.

#### 4.20 FLINT CORN AND FLINT AND DENT CORN

Flint Corn. *Corn that consists of 95 percent or more of Flint corn.*

Flint and Dent Corn. *Corn that consists of a mixture of Flint and Dent corn containing more than 5.0 percent but less than 95 percent of Flint corn.*

A kernel of Flint corn normally has a rounded crown and is usually smaller than a dent kernel.

A kernel of Dent corn is normally characterized by a distinct depression or dent in the crown of the kernel.

In mixtures of Flint and Dent corn, there is frequently a difference in the color of the two types. The shape of the kernel, the size, the texture, and the color characteristics are used in making a determination in mixtures of Flint and Dent corn.

**Basis of Determination.** Determine the special grades Flint, Flint and Dent on the characteristics of the kernels in the sample. When an analysis is necessary, use a portion of 250 grams of BCFM-free corn. (Reference: Visual Reference Image No. (C) [OF-Flint & Dent Corn](#))

**Certification.** When applicable, record the words "Flint" or "Flint and Dent" on the certificate in accordance with Section 4.4, Special Grades.

#### 4.21 WAXY CORN

*Corn that consists of 95 percent or more waxy corn according to procedures prescribed in FGIS instructions.*

**Basis of Determination.** When corn appears to contain 95 percent or more waxy kernels, test the sample to determine whether the special grade Waxy applies. Use exactly 100 kernels cut out of a 35-gram portion of BCFM-free corn.

When determining class for a sample of corn designated Waxy, apply the following guidelines:

For the special grade Waxy, the requirement of white kernels of corn with a slight tinge of light straw is not applicable; however, kernels which are "slightly yellow" are considered as corn of other colors. All other color requirements remain in effect for all classes of Waxy corn. (Reference: Visual Reference Image No. [\(C\) O.F.-7.8 Slight Yellow In \(White Waxy\)](#))

Procedure for Testing Waxy Kernels of Corn. For required materials and equipment, see chapter 1, section 1.17.

- a. Pour 30 ml of the iodine stock solution into a spray bottle and dilute it with 30 ml of distilled water.
- b. Cut each of the whole kernels lengthwise (tip to crown) or across the top exposing the starch in the endosperm. Place one-half of each kernel into a petri dish and discard the other half.
- c. Carefully spray (do not soak) all the cut kernels with the iodine solution.

### **CAUTION**

**Wear safety equipment. Spray iodine solution only in a well ventilated area or within the working area of a laboratory hood. To prevent staining tables and surrounding areas, place the petri dish on a covered surface before spraying.**

- d. Approximately 1 to 3 minutes after spraying, the starch of the Waxy corn kernels will turn a red or reddish-brown color. The starch of nonwaxy kernels will turn a blue or violet color. Consider samples with 95 kernels (95 percent) turning red or reddish-brown color as Waxy corn. (Reference: Visual Reference Image Nos. [\(C\) O.F.-7.9 Waxy & \(C\) O.F.-7.91 Non Waxy](#))

**Certification.** When applicable, record the word "Waxy" on the certificate in accordance with Section 4.4, Special Grades.

#### 4.22 OFFICIAL CRITERIA

Stress Crack Analysis. Stress crack analysis is an “official criteria” determined only upon request. It does not affect the grade designation.

**Basis of Determination.** Stress crack analysis is determined on the basis of a predetermined number of whole kernels. Do not include kernels that are broken, chipped, or cracked (i.e., a ruptured seed coat), or which otherwise limit the ability to identify stress cracks, e.g., waxy or discolored kernels. Use a divider to obtain the appropriate analytical portion size based on the requested service. Removal of broken corn and foreign material prior to obtaining the analytical portion may facilitate whole kernel selection.

- a. For percent **total** stress crack analysis, obtain approximately 25 grams to select 50 whole kernels. Multiply the number of stressed kernels by 2 before reporting.
- b. For percent **single, double, and multiple** stress crack analysis, obtain approximately 50 grams to select 100 whole kernels. Report number of stressed kernels as obtained.

**NOTE: The above portion sizes are the minimum required. Upon request, larger portion sizes are permitted. If a larger portion size is used, adjust test results as appropriate before reporting.**

- c. Upon request, separate and count the number of kernels in the three stress crack categories: single, double, and multiple stress cracks. Visually inspect whole kernels on a light board for internal narrow cracks in the endosperm as follows:
  - (1) Place kernels on the light board with germ side down. Visually inspect each kernel for stress cracks and separate stressed kernels.
  - (2) Turn remaining kernels germ side up. Visually inspect each kernel for stress cracks and separate stressed kernels.
  - (3) Count the total number of stressed kernels.

**Certification.** Report the percentage of total stress cracks or the percentage of single, double, and multiple stress cracks in whole percent in the “Remarks” section of the certificate.

- b. Presence of Waxy Kernels. This procedure is applicable only for determining the presence of waxy corn and does not replace the procedure for determining the special grade “Waxy.”

**Basis of Determination.** A representative portion of at least 35 grams of corn on the basis of the sample as a whole.

Testing Procedure. See Chapter 1, section 1.17 for Iodine test materials.

- (1) Pour 30 ml of the iodine stock solution into a spray bottle and dilute it with 30 ml of distilled water.
- (2) Coarse grind the 35 gram sample.

**NOTE: A Romer Mill – Model 2A, Bunn Grinder, or equivalent, must be used to coarsely grind samples. The grinder must be adjusted so that 80 percent or more of the sample remains on top of an 8/64 round-hole sieve and that all kernels are broken open to expose the endosperm.**

- (3) Carefully spray (do not soak) the entire sample with the iodine solution. If an 8/64 sieve was used to separate the broken kernels from the fine material, then spray only the material that remains on top of the sieve.

**CAUTION: Wear safety equipment. Spray iodine solution only in a well ventilated area or within the working area of a laboratory hood.**

- (4) Shortly after spraying the kernels (approximately 1 to 3 minutes), the starch of waxy corn kernels will turn a red or reddish-brown color. The starch of nonwaxy kernels will turn a blue or violet color. (Reference: Visual Reference Image Nos. [\(C\) O.F.-7.9 Waxy](#) & [\(C\) O.F.-7.91 Non Waxy](#))
- (5) Analyze the sprayed kernels to determine if any waxy kernels are present. If a single kernel is determined to be “waxy”, consider the sample as positive for the presence of waxy corn, otherwise, the sample is negative for waxy kernels.

**Certification.** Results are certified in the “Remarks” section of the certificate with one of the following applicable statements.

“This sample contains waxy corn.” or “This sample does not contain waxy corn.”